SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

No. 1361.—Vol. XXXI.] LONDON, SATURDAY, SEPTEMBER 21, 1861. [WITH JOURNAL] STAMPED.... SIXPENCE. UNSTAMPED. FIVEPENCE.

SOUTH WALES INSTITUTE OF ENGINEERS.

The annual general meeting of members of this valuable and, we are glad to find, prosperous scientific institution was held in Swansea on Friday and Saturday. The Royal Institution of South Wales had been kindly placed at the disposal of the Society, and the theatre of the building was appropriately fitted up. On the table in front of the President's chair were placed one or two models of collieries, many valuable scientific instruments, including an aneroid barometer, exhibited by Mr. R. B. Hennessey, of Swansea, a newly-invented shot, designed by Mr. Benjamin Hill, of Clydach, near Swansea; specimens of compressed patent fuel, and other articles of interest to gentlemen engaged in scientific pursuits. The walls were hung with diagrams, sections, &c., for the purpose of more fully explaining the various suggestions and appliances referred to in the papers about to be discussed. There was no public business transacted on Friday, but at four o'clock in the afternoon the members of the council met for the disposal of the usual routine business of the Society. The President, Mr. Lionel Brough, F.G.S., Government Inspector of Coal Mines for the Bristol and Monmouthshire district, took the chair. At the council meeting Mr. Robert Eaton, of Bryn-y-Mor, near Swansea, and Dr. Thomas Williams, F.S.A., were duly proposed and seconded as members of the Institute, and will be duly ballotted for at the next meeting, in accordance with the rules.

Saturday.—The members and friends of the Institute assembled in the Theatre of the Royal Institution at eleven o'clock. The following gentlemen were present:—Messrs. Lionel Brough, F.G.S., President; Thomas Evans, F.G.S., Government Inspector of South Wales, vice-president; Alexander Bassett, Cardiff; Charles Lean, Swansea; Charles Lean, jun.; George A. Lean; Wm. Williams, Llanelly; Rhys Williams, Llanelly; Henry Harry, Llanelly; Handel Cossham, F.G.S., Bristol; D. Llewellyn, Glyn Neath; John Cox, Caerleon; M. Moggridge, Swansea; Christopher James, Aberdare; H. Huxham, Pont-y-pridd; Marcus Moxham, Swansea; G. G. Francis, Swansea; John Lewis, Swansea; D. W. James, John Trotter, Richard Bedlington, J. L. Thomas, John Thomas, E. Daniel, W. Williams, Landore; J. W. Lewis, H. W. Lewis, N. K. Allen, H. W. Hodges, London; Joshua Richards, J. M. O'Donoghue, J. C. Richardson, Mayor of Swansea; John Glasbrook, Swansea; Thomas James, Ebenezer Davies, Swansea; John Phillips, Wilkins Trick, Ynisedwyn; Evan Davies, Swansea; Andrew Davies, E. Windsor Richards, Philip Rogers, Swansea; D. Nicol, M.D., Thomas Walters, jun., Swansea; Thomas Powel, Landore; Robert C. Fisher, Ystalyfera, &c.

The President (Mr. Lionel Brough) took his seat soon after 11 o'clock, and, addressing those present, said he had now the pleasure of declaring the session duly opened. That was the last session of the Institute for the current year, and that day concluded the fourth year of their existence. It was pleasing for him to be able to say that they continued to grow and increase, the number of associates and graduates being larger than ever before. They now numbered 202 members, which, considering the Institution was only in its infancy, proved the very strong desire on the part of the inhabitants of the principality to meet together and discuss scientific pursuits. Although there were 202 members on their books, it was arranged at the previous day's council meeting that they should revise the list, and probably some few who had never attended the meetings might be removed altogether. As regarded, therefore, their strength and numbers they felt they had not been neglected as a body. Although they had been but four years in existence, still death had been busy amongst them, and they had lost three members of great usefulness and of great talent and ability. The first gentleman to whom he would allude was the late Mr. Samuel Truran, the engineer of the Dowlais Works, a gentleman who was not only eminent in his works and profession, but a mechanical and civil engineer of great ability. This gentleman lost his life by an accident of an extraordinary character on Oct. 5 last. Those engaged in metallurgy would know that the gases which were taken off the tops of blast-furnaces were made use of for steam and other purposes. Unfortunately, some of these gases, probably owing to the imperfection of the culvert or channel through which they had to pass, escaped and came up through the floor of the room in which Mr. Truran was at work, and when found he was quite dead. They had, therefore, to deplore the death of this gentleman—suddenly cut off in the most useful part of his life, and when he was most valuable to his employers, and to the society by which he was surrounded. Then they had to deplore the death of Mr. Caleb Davies, the engineer of the Nant-y-Glo Works, who had for many years conducted those works with great profit to his employers and credit to himself. He, too, was taken from them early last year, and they had to regret his loss as a most valuable member of their Society. The third gentleman whose death they had all to deplore was a gentleman whom he (the President) had the honour of proposing a member of the Institute. He alluded to Mr. Dickens, a brother of the celebrated and greatest of all English novelists. Mr. Dickens was a brother colleague of himself (the President) and his friend Mr. Thomas Evans, and was a most useful and practical man in that walk of life in which he was called upon to act. They lamented his death, whilst he believed every member of the Institute, and all who were connected with scientific pursuits, would also deplore the great loss which they had sustained. He would now again refer to their past proceedings. He had already stated that this was the last session for another current year. The first of their quarterly meetings was held in Merthyr, the second in Cardiff, the third in Newport, and this, the closing one, in Swansea. The proceedings of the present meeting would also complete the second volume of their Transactions, and the volume would be issued in about two months, and it would be found to contain some valuable papers and useful and practical discussions. He had only now, in the name of the Institute, to offer their general and most respectful thanks to the council and gentlemen of the Royal Institution who had so kindly permitted them to have the use of that room, in which to hold their meeting. In all their places of meeting they did not visit such a convenient and handsome room, and they all felt indebted to the gentlemen of the Royal Institution for the great boon granted them. He had hardly thought it necessary to allude to another portion of their affairs—their financial position. He was happy to be able to say that they were quite as successful in this as in other respects. (Hear, hear.) They had a balance in the hands of the bankers—115*l.*, after payment of all their liabilities, and the accounts were always found to be kept in most admirable order. Although the Society was so young—quite in its infancy, it was most satisfactory to find that they received friendly communications, and exchanged papers and books with all the sister institutions in the kingdom; indeed, they all seemed to fraternise together as members of one affectionate family. After one or two observations, the President called upon Mr. Handel Cossham, F.G.S., of Short-Wood Lodge, Bristol, to read his paper upon—

THE WORKING OF THIN SEAMS OF COAL.

Mr. Cossham, after a few prefatory remarks, said that the paper which he was about to read was an eminently practical and important one. Probably more than one-half of the coal which Nature had implanted in the bowels of the earth existed in thin seams under 2 ft. thick, and when they remembered that the annual drain upon the supply reached no less than 80,000,000 tons, they would at once see the necessity of doing all in their power to produce economy in the working—to develope their resources, and to utilise, as far as they possibly could, every portion of those resources. He was fully convinced in his own mind that fully 50 per cent. of coal was at present lost from one of three causes. First, being left underground untouched; secondly, by being only partly raised, owing to unskilful and unscientific management; and, thirdly, by being wasted in its use after being brought to the surface. It was upon the first of these propositions that his paper now treated. In the Newcastle district alone there were thin seams of coal, all under 3 feet thick, which, if properly and economically worked and used, would supply the present consumption for 400 years, so that there need be no fear of the consumption falling short. Probably the first important question which would be asked was, what thickness of coal could be worked at a profit? Of course the answer to that would depend in a great measure upon the quality of the coal; but, in his opinion, every seam of coal at and over 18 inches ought to be worked. He had the superintendence of a colliery at the present time, which produced between 2000 and 3000 tons per week, and every seam was under 3 ft. thick. As to the best way of working thin seams of coal, he would say that the long wall system should be adopted, and all the coal must be worked out of thin seams if they were to be worked profitably. He would also recommend the adoption of gob-roads for air-ways instead of pillars; secondly, loading the trams at the face, and thus avoiding the shifting of coal. The gob-roads should be carried to the face every 15 or 20 yards. About 8 cwts. should be placed on each tram, and each tram should weigh about 3 cwts.—the roads to be 21-inch gauge. As to the cost of working thin seams, he should say that seams from 2 ft. to 2 ft. 6 in. thick should be worked at 4s. 3d. per ton for labour; materials, 1s. per ton, and other items, making a total of 5s. 9d. per ton. Seams of from 18 in. to 2 ft. thick ought to be worked at 4s. 6d. per ton labour, other items making a total of 5s. 10d. or 5s. 11d. per ton. Seams from 12 in. to 18 in. should be worked at 5s. per ton labour, other items making a total of 6s. 3d. or 6s. 4d. per ton. These would be exclusive of interest upon the capital employed. Mr. Cossham then remarked that the liability to danger and fatal accidents were very much lessened in working thin seams as compared with thick. The risk and danger of working coal above 5 ft. is much greater than in seams below that thickness. He need only refer, in proof of what he now stated, to the working of the thick seams in the South of Staffordshire. He had lately visited that district, and was struck with the fearful risk and danger attending the working of coal there, and also with the terrible waste which is going on there. Mr. Cossham here said—"*I do not hesitate to say that thousands of people have been transported for less crimes than are committed against God and humanity by the reckless, careless destruction, and wasteful way in which that wondrous field is now working, involving, as it does, the destruction of over* 300 *lives annually, and over* 60 *per cent. of coal.*" In South Staffordshire it was found that one life was sacrificed for every 83,000 tons of coal raised, whilst in Somersetshire the loss was only one in 110,000 or 120,000, or in some instances 150,000 tons. Mr. Cossham concluded by remarking that it must be regarded as a national loss that thin seams were not more extensively and profitably worked.

The President said that first of all the best thanks of the members of the Institute were due to Mr. Cossham for the very valuable hints which he had given them. He had spoken of the loss of coal—of that valuable article of commerce which formed the basis of the wealth of their wonderful and mighty empire. There could be no doubt but that coal formed the basis of that commercial union of the two greatest nations on the earth (whose flags now faced them), and the benefits of which they were already beginning to realise. There could be no question but that when the benefits of that commercial union became more fully known and appreciated, that far larger quantities of Welsh coal and Welsh iron would visit the fine empire of France. It would appear to gentlemen in the habit of working Welsh mines that the plan recommended by Mr. Cossham of loading trams at the face was in opposition to what they adopted. Every practical collier present well knew that they were bound to make all possible use of the backs or slips—but it should be remembered that Mr. Cossham got his coal by working at right angles, and therefore he had laid out his colliery in the best possible manner. The colliery was in his (Mr. Brough's) district, and he could only say that he never visited a colliery which gave him more entire satisfaction. (Hear, hear.) He should like to hear what Mr. Alexander Bassett, of Cardiff, had to say upon the subject.

Mr. Bassett said he had not come prepared to offer any observations upon this subject—in fact, he was not aware that the paper would be discussed at the present meeting, otherwise he would have obtained some information as to the cost of working thin seams in other districts. He was quite aware that in Bristol they were very much worked, and worked very cheaply—in fact, there were but few thick seams, and therefore they were obliged to work thin seams. In a colliery in which he was interested they were working a seam only 12 in. thick, and there was a special clause in the agreement that if the coal went below 10 in. the lessor should not compel the lessee to work it, such was the extra costs of working thin seams in this district. Some of the thin seams in this district were worked at a very low cost, whilst the percentage of small was comparatively nothing—the coal, in fact, was got out the entire thickness of the seam, and there was scarcely any loss. That coal was usually sold at about 10s. or 12s. per ton, but if hand-picked it fetched as much as 14s. per ton. With regard to the cost of timber, it was very much less in the Bristol than in the South Wales district. Then, again, in Bristol there was no gas—collieries were easily ventilated, and they had but few or none of those difficulties to contend with in working thin seams which they had in South Wales. The price of labour was very much lower also in the Bristol district than in Wales, and considering all these things, he believed they were able to work the thin seams as profitably as those of Bristol.

Mr. Cossham said he did not think there was any very great difference in the price of labour in the Bristol and South Wales district. In his colliery a man working eight hours per day could easily make 3s. per day.

The President said that some time ago he himself witnessed the working of a seam of coal in Staffordshire which was only 10 inches thick, and the coal was got out nearly all large. With regard to the risk and danger of working the thick seams of coal in Staffordshire, the horrible slaughter described by Mr. Cossham was, unfortunately, too true. Some years ago, however, he had suggested a method whereby such fearful loss of life should be prevented. In fact, he delivered a lecture upon it, which was afterwards published by the colliery owners in Staffordshire; and in one colliery where his suggestion had been adopted for many years past—that of the South End Colliery—not a single life had been lost or accident occurred. He had seen it practically impossible to prop up a roof 30 ft. high, and the plan which he, therefore, suggested was simply to work by two slices or interstices to divide the seam in two in the working; and where this plan had been adopted there had not occurred a single accident either to life or limb.

In reply to a question put by Mr. Thomas Evans, Mr. Cossham said that it cost 1s. 2d. per ton of 20 cwts. to cut the coal in the thin seams in Bristol. Gobbing, timbering, and all underground labour he estimated at simply 9d. or 10d. per ton extra.

The President said that when they came to consider the cost of timber, &c., it was not such a very low cost for working these thin seams. The Welsh colliers were not over-paid either, for they had to do the timbering themselves for the price they obtained.

Mr. Thomas Evans said that in South Wales there were several seams of coal cut cheaper than that cited by Mr. Cossham. In Pembrokeshire especially only 5d. per ton was paid for the cutting, whereas Mr. Cossham paid 1s. 2d. In Aberdare, where the seams were 7 and 8 ft. thick, the price paid was 1s. 9d. per ton. A thin seam in Aberdare, about 2 feet thick, was worked at less cost than some of the thick mines. As regarded the thin seams of Bristol, which Mr. Cossham had alluded to, of course there was no comparison as regarded the thick seams of Aberdare, in point of danger, &c. There were no seams so dangerous as those of Aberdare. Doubtless many lives might be annually saved by strict precautionary measures on the part of the managers, and also on the part of the men themselves, but there could be no question that the seams of Aberdare were in themselves exceedingly dangerous to work.

The President remarked that in some parts of Monmouthshire and Glamorganshire the bottom measures were exceedingly difficult and dangerous to work. There was nothing in Somersetshire at all parallel to them in point of danger. Another reason why the slaughter of life in Staffordshire was so large as compared with Bristol was that there was no dangerous or explosive gas in the Bristol mines. Then, again, no death could occur from falls of roof in the Bristol collieries, which was a source of many fatal accidents in those districts with thick seams.

Mr. Bassett said he knew a pit in this district which had the coal put into the trucks at 2s. 6d. per ton, which charge included everything with the exception of royalty.

After some remarks from Mr. Williams, of Llanelly, the President thanked Mr. Cossham for his very valuable paper, which will be duly printed, and form part of the Transactions of the Institute. The discussion then terminated.

THE BRISTOL MINING SCHOOL.

Mr. Handel Cossham said that he ought to apologise to the Institute for bringing the subject of the Mining School of Bristol under their notice, but as all present were connected with mining and engineering, perhaps it was not altogether irrelevant. He would state in the first place, that for the last seven years they had had a mining school in Bristol more or less in operation; in fact, he believed it was the first school of the kind established in England. The founders and supporters never aimed very high, the most important object which they had in view being to establish a school in which to teach the lower orders—such as overmen, engineers, &c.—such information as was imparted in Mining Schools, and thus to make them fit to perform the important duties they would be called upon to perform in after life. During the seven years the school had been in existence they had upon an average eight pupils, but they had at the present time no less than twelve; and by a recent arrangement with the Trades' School, they received the assistance of the teachers and the mining master, Mr. Wood, who was a most able man. He would remind those who were present that three out of the twelve pupils now in the school were from the district of Wales, and he hoped this fact would connect their sympathies and support with the school. They had no school of the kind of their own, and, therefore, he thought the gentlemen present and others interested in engineering and mining pursuits could render them considerable help, both by recommending them fit pupils for reception, and if they could render them some more substantial aid in the way of donations and subscriptions, they should be exceedingly glad.

The President said there could be no doubt but that they should have a mining school on the Welsh side; and before he had been removed from the district he had, in conjunction with his friend Mr. Thomas Evans, the present Inspector for South Wales, worked and striven hard to bring about so desirable and beneficial an object. Since he had been removed he had assisted Mr. Evans in every way he could, but hitherto they had not received sufficient support to establish this Mining School for South Wales. He, however, did not altogether despair, for it was an institution which ought to be carried out. It was a long distance and very expensive to send young men from the Welsh district to the school at Bristol, and several others would, doubtless, receive the benefits accruing from such a school if established in their own locality. As an instance of the good resulting from institutions of the kind he was now advocating, he would mention that at the present moment there was a young man in the Bristol School who formerly cut coal in the Risca Colliery, and who had two brothers killed in the recent awful explosion there. Although that young man had only been in the school six months, he was a considerably better algebraist than he (the President) was, and in several other sciences he had already shot ahead. (Hear, hear.) If a young man taken from a colliery could accomplish this in six months, it showed the great value of the Mining Schools. As he had before remarked, he hoped they would soon have a school of their own; but until that time came, he had the greatest pleasure in recommending to their notice and to their support the very excellent school established in Bristol. He was glad to be able to say that the men who had attained the greatest distinction in the Bristol School were those who came from the Welsh side. The advantages and education imparted in this school could not be obtained in any other school in the district; but he would not have advocated the Bristol School if they had such an institute of their own. In the interim, however, he would observe that no other school offered such facilities to young men engaged in mining operations as the Bristol Mining School, with the exception, perhaps, of the school in Jermyn-street.

The matter then dropped, and Mr. Cox read a letter from Mr. W. Andrews, of Ebbw Vale, the President elect for the ensuing year, apologising for his absence, it being unavoidably caused by a disturbance with his men.

ELECTION OF NEW MEMBERS.

The President then declared that the following gentlemen had been balloted for, in accordance with the rules of the Institute, and duly elected members,—Mr. J. Nasmyth, of Aberdare, Glamorganshire; Mr. E. Cook, of Newport, Monmouthshire; Mr. H. Hewitt, Bristol, Somersetshire; Mr. P. Jeffcock, of Duffield, near Derby, and Mr. C. Kirby, of Newport, Monmouthshire. The President said that the whole of these were practical men, and would, doubtless, prove valuable and efficient members.

THE CORNISH ENGINE.

The President said that the next paper which would be discussed would be that of Mr. Sims, of Redruth, upon the Cornish engine. Mr. Sims was a most able and practical engineer, with great powers of thought and application in bringing his suggestions to bear. In fact, since the time of James Watt, no county has produced more able and talented engineers than Cornwall. The Cornish pumping-engine was the most extraordinary engine in the world; and what the engineers of Cornwall were able to do with a small quantity of fuel had never been arrived at elsewhere. In Cornwall the price of fuel was from 15s. to 20s. per ton; and where an engine consumed from 4000 to 5000 tons per annum, that, virtually, was the profit of the mine. Mr. Sims had studied how to economise fuel, and thus the economy of fuel which he had brought to bear was the profit of the mine. The engine which had been erected had produced an effect which was perfectly extraordinary, for with 2½ or 3½ lbs. of fuel, Mr. Sims had been able to get the same power as they in Wales did with between 20 and 30 lbs. of fuel. He (the President) had not been able to devote great attention to the paper: the fearful calamity in the Risca Colliery, in his district, had thrown him very considerably back in his work, but he should be very glad to hear any gentleman offer observations on the subject.

Mr. T. Evans said the Cornish engines were rather extensively used in his district. One at the Dowlais pits had worked at little cost for many years.

Mr. J. Glasbrook said that his firm had two of these engines, and they were working most satisfactorily—in fact, he did not think there were better engines in the world. Although fuel was not of so much consequence to them as it was in Cornwall, yet every colliery proprietor wished to work his engines as economically as possible.

Mr. W. Williams, of Llanelly, said there were two of these engines in his collieries. They were, perhaps, 100 fms. down. There were three lifts and 19-in. pumps, which made four or five strokes per minute. The fewer the number of strokes per minute the more efficient the work. The beams were not equal—the stroke in the cylinder was 8 feet, and in the pit 9 feet.

Mr. T. Evans said that it might not, perhaps, be generally known that there was an engine in Swansea at the present time which pumped from 8000 to 12,000 gallons of water per minute from the half-tide basin into the docks.

The President said he had heard of this engine before, and it had been stated to him that it was equal to some of the most remarkable and powerful machinery in England.

Mr. G. G. Francis said that doubtless the members of the Institute would be glad to see this machinery, which could be done after the discussion.

The President said that as Mr. Sims was not present, and as the paper had been partly discussed at the last meeting, he would bring the subject to a close, by proposing a vote of thanks to Mr. Sims for his able paper. The resolution was carried unanimously.

UNDERGROUND MACHINERY.

The following valuable paper, by Mr. C. James, was then discussed:—The magnitude of modern collieries, both as regards the depth of the shafts and the acreage of coal to be won from them, has caused the use of machinery of a corresponding size and power; some of the engines, as those at Dukinfield, near Manchester, and those at Navigation, in our district, being celebrated for their size and finish. When the requirements of the colliery allow this machinery to be placed on the surface, the questions for the engineer rarely present any peculiar or unusual difficulties; the want of power, however, is by no means confined to the surface. Pumping and winding have often to be done some hundreds of yards down, and it may be 1000 yards from the bottom of the shaft; and in situations like these it is often a difficult matter to decide upon the best means to be employed. The advantages that result from the increased use of machinery in these places are becoming every day more recognised; and underground engines are now common enough in every large coal field. Steam-power has been more used than anything else; and, under favourable conditions, is of course, the best, from its cheapness and the ease with which it was managed. Most of the engines are supplied with steam from underground boilers, although in some cases it is conveyed from the surface. A good example of this, although not upon a very large scale, may be seen at Deep Duffryn Colliery, where the steam is carried down a 286-yard downcast pit, and 260 yards along a level; altogether a distance of 546 yards. The engine has an oscillating cylinder 12 inches in diameter, 16-in. stroke, and winds up an incline 480 yards long, with an inclination of 2¾ in. in the yard. It brings up three trams, each holding about 1 ton of coal, in 2½ minutes. The single boiler which supplies the steam is 40 ft. long by 5 ft. diameter, and is worked to about 60 lbs. pressure; the pressure in the receiver is nearly, if not quite, the same when the engine is at rest, but is lowered to about 30 lbs. at the end of each trip. The few minutes spent in unhitching the trams are sufficient to restore the pressure in the receiver. The pipes which convey the steam are only 2 in. in diameter. Large engines, however, almost without exception, are supplied from boilers near them, as the loss of power from condensation would be serious if the steam were carried far. In most cases there is comparatively little difficulty in getting rid of the products of combustion, because the boilers and engine are near the upcast shaft, and often greatly assist the ventilation; and none of those evils arise which are met with when the smoke and waste steam pass through ordinary air-ways; the heat and moisture act very quickly upon the top and sides, causing frequent and heavy falls, which block up the air-way and stop the ventilation. These falls cannot be removed without stopping the engine and extinguishing the fires for some time previously, the air in the return being, of course, unfit to work in. In some cases, in spite of the difficulty of keeping the return open, the smoke is taken to the upcast through old headings and levels long distances. At one colliery in Glamorganshire the engine and boiler are situated upwards of 1200 yds. from the upcast pit. Through the whole of this distance the waste gases and steam are conveyed through abandoned roadways. The engine is supplied from a boiler 33 ft. long by 4 ft. 6 in. in diameter, and is used to pump and wind from a vein of coal 47 yards below it. It works regularly, but much difficulty is often caused from want of draught; the result of falls in the old roadways. The removal of these falls is a constant source of expense. An engine in a very similar position at a colliery in Northumberland was long worked without casualty, at a distance of 900 yards from the upcast; at last, however, the coal in the return took fire, probably from the soot accumulated on the sides and top. The difficult and expensive task of extinguishing the fire being finished, the engine was again set to work, but not before a double archway, similar to that shown at fig. 1, which is a drawing of the smoke drift at Cwmbargoed pits, had been built for the whole distance of 900 yards, so as to prevent a recurrence of the accident. Many cases of fire from the same cause, besides the one alluded to, have taken place, some of them involving loss of life; and point to the necessity of great care and circumspection whenever large boiler fires are placed near a vein of coal.

The actual distance at which an engine may be placed from the bottom of a shaft, of course, depends upon many conditions—the ventilating power of the pit, the nature of the ground, and, therefore, the state of repair in which the air-way can be kept. The difficulty, however, of successfully working a steam-engine evidently increases with the distance, and when this is great, and the power required is large, the expense of safely conveying so large an amount of hot gases as would be generated to a proper place of exit becomes so heavy that other means must be adopted, or the idea of using machinery at all abandoned. Other methods have been suggested and employed; the simplest is probably that of transmitting the power generated by a steam-engine in some safe place by means of wire ropes. Both winding and pumping are effected by these means at long distances, and an instance or two may not be uninteresting. At the Shotton Colliery, Durham, an underground engine near the bottom of the upcast winds coal from the great distance of 2300 yards, the inclination of the road for 1400 yards being 3-16ths in. in the yard, and for 700 yards ⅜ in.; the last 200 yards are level. Sixty-four tubs, each holding about 8½ cwts. of coal, are drawn up each journey; the empty tubs are drawn back by means of a tail-rope 4600 yards long, which works on sheaves on the side of the road-way. In our own district, the winding-rope at the Dowlais Brewhouse Level is probably the longest, being 3000 yards long; it draws 30 to 35 trams, or about 36 tons of coal each trip. Wire-rope pumps are, I believe, more used in Cornwall than in Wales, but some have been successfully worked in places where it would be difficult to apply other means, and they are certainly very convenient. A pump is worked thus in the Swansea Valley, in a colliery 180 yards deep, at the bottom of an incline 210 yards long, with an inclination of 13 in. in a yard; 1¼ in. wire-rope works the forcer, which is 6 in. diameter, with a 5-in. stroke. But useful as wire-ropes are, and numerous the places where they can be advantageously used, they by no means remove the difficulty where

the engine itself is required to be placed far from the pit. To meet this case, and when steam is considered inadmissible, water-engines of different descriptions have been used. In some places, as where the engine is wanted near the bottom of the downcast pit in which there are pumps, and the upcast is a long way off, a most disadvantageous situation for steam, they might be advisable. The pressure of a column of water equal to the depth of the shaft would be the power employed, and the waste water would be pumped back again. Many forms of water-engines have been proposed, but the only ones adapted for winding are those of Sir Wm. Armstrong. They consist essentially of three or four rams working on a shaft, something in the manner of a three-throw pump; the rotary motion of the shaft is easily applied to any purpose. These engines were first used for opening heavy dock-gates and similar work, as at Swansea, where they may be seen working to great advantage. They are also used for shunting wagons, hoisting goods into warehouses, &c., on some of the principal stations of the Great Western Railway. For winding purposes, two of these engines have been worked for some time at South Hetton and Allenheads. The engine at South Hetton has, however, been lately replaced by the older and more familiar steam-engine, and I am not aware of any others being at present at work. Although admirably adapted for transmitting power on the surface, and often perhaps in mines, this, as well as every other water-engine, is liable to the serious objection of giving off a large quantity of waste water, which is often as difficult of removal as the waste gases of a steam-engine. This would be a great obstacle when it was wanted to the deep of a large colliery, a case which, from the rapid extension of coal-works in the North Crop, may probably be of very frequent occurrence in this district.

There is, unfortunately, but little chance at present of a practically good and cheap electro-magnetic engine being produced, great as have been the ingenuity and skill expended upon the subject; if there were, in few cases would it be of greater service than to the coal miner. An engine under perfect control, which could be placed at once from the shaft, and would work without giving off heat, or any other troublesome product, would be most useful; but, for the present, less perfect machines must be employed. An apparatus, in which electricity plays some part, although not the most important, has been proposed for mining purposes; and although at present but little known, may merit consideration, and, perhaps, a trial. This, of which figs. 2, 3, and 4 are drawings, consists of a horizontal cylinder, with piston, &c., as in a steam-engine; instead, however, of steam coal gas is the power employed, which is admitted behind the piston, mixed with air, and exploded by means of a spark from a small galvanic battery. The expansion of the air, caused by the ignition of the gas, is quite sufficient to work an engine of considerable power. In the particular engine alluded to, for more than one has been erected upon the same principle, although to different designs, the gas is admitted to each side of the piston alternately, through the tube G and valve T, being mixed with air which is admitted through the tube A; it is then exploded by a spark between the points of the wires f and f', and having forced the piston to the end of the cylinders, escapes through the valve T'. The contrivance for making and breaking the current, and so producing the spark in the cylinder, is attached to the cross head of the piston-rod, and consists of two slips of metal, which slide upon the insulated metal rods $a\,b$, $c\,d$, which are placed in contact with a small battery. When the piston reaches either end of the cylinder, one of the small pieces of metal slips off the rod, and in so doing breaks the current, and causes the spark. A considerable amount of heat is of course produced by burning the gas; to prevent, as far as possible, the ill effect this has upon the working of the engine, a slow stream of water is kept running through the space E, and pipes F E. An engine of 4-horse power, the manufacture of Mr. Lenoir, was working in Paris in June, 1860, driving some half-a-dozen iron cutting tools, lathes, &c., the only power being conveyed in a small pipe from the street gas main. The consumption of gas was stated to be about 20 cubic feet per horse power per hour. It was managed with the greatest ease, and was under perfect control, the speed being regulated by the quantity of gas admitted, precisely as in a steam-engine; and the heat, steam, and waste gases were much less than they would have been from the boilers of a steam-engine of equal power. The engine, I understand, has been examined and reported upon by a committee of the Academy of Sciences, but I have been unable to ascertain their opinion. Of course it could not compete with steam under ordinary circumstances, especially in this district, where coal is so abundant; but if it has the power represented, it may easily be made serviceable in collieries, from the ease with which gas might be carried from the surface to any distance underground; and from the comparatively small quantity of heat and steam that would have to be got rid of.

But the best and most practical engine that has yet been used for underground work, where steam is inadmissible, is that worked by air, compressed on the surface, and carried underground in pipes; and it is one the use of which, from the success that has hitherto attended it, will very probably be much extended. The practical failure of the atmospheric railways, which were also worked by air-engines, does not affect the success of compressed air-engines; in the former, the air being pumped out of a tube, the motive-power was the pressure of the atmosphere upon the piston working in it, and could not equal 15 lbs. per inch, however well the engine worked. In the compressed air-engine, however, this is by no means the case, pressure of 100 to 120 lbs. per square inch being obtainable. The air, compressed by steam or water-power on the surface, and conveyed, as stated, to the engine, is used as though it were high-pressure steam, and is managed with equal facility. The idea is by no means a new one; the small models of steam-engines are used as though it were high-pressure steam, and is managed with equal facility. The idea is by no means a new one; the small models of steam-engines in popular exhibitions having been long worked by these means; and, as I understand, an engine in the Government powder mills at Constantinople was worked thus some years ago. It is only recently, however, that the principle has been carried out in England to any extent, although it now seems likely to be much used. The first of these engines was erected at Govan Colliery, near Glasgow, in 1849, by Messrs. Randolph, Elder, and Co., and a description, from which the following is taken, was read before the Institution of Mechanical Engineers in 1857. It being necessary to place an engine 706 yards "in-bye" from the bottom of a shaft 176 yards deep, and steam being considered inadmissible, it was determined to try compressed air; the compressing engine was designed and constructed by Messrs. Randolph, Elder, and Co., and has been found to answer the purpose completely, after many years' work. "The cylinder is 15 in. diameter, and has a 3-ft. stroke; the two air-pumps, which deliver the compressed air into the reservoir, and thence into the main pipe, are each 21 in. in diameter, with a stroke of 18 in. They are placed inverted, with the piston-rods passing out below, where the stuffing-boxes are not exposed to the pressure of the compressed air, and are worked with cross heads sliding in vertical guides by means of side roads from the beam. The air-pumps are fitted with ball valves, of which there are three sets to each pump; each set consisting of 44 brass balls, 2 in. in diameter, arranged in three eccentric rings. The balls are confined by separate cages to a lift of half an inch. Provision is made for preventing leakage through the valves, by a stratum of water constantly covering the piston valves and the delivery and inlet valves, through which all the air had to pass. A small pump, 3 in. diameter, is employed to supply water for this purpose, and delivers it into the centre reservoir, from which it flows through pipes into each of the air-pumps, during the period of their downward stroke. The surplus water is discharged at each upward stroke through the delivery valves, and flows over the top into the centre reservoir, keeping the delivery valves also covered with water; in this way the compressed air is entirely discharged, and there is no loss of power from expansion of air behind the piston at the beginning of the downward stroke. The air-pump barrels are lined with brass to prevent corrosion, and the pistons are also faced with brass, and are made without packing, being merely turned a good fit to the cylinders. The usual speed is about 25 revolutions per minute, with a pressure of steam 18 lbs. per square inch, giving a pressure of air averaging about 20 lbs. per square inch. The air-engine itself is an old high-pressure beam engine, with a cylinder 10 in. diameter and 18-in. stroke, and works about 25 revolutions a minute. The pressure of air at the lower engine is only about 1 lb. per square inch below the pressure of the compressing engine at the top of the pit. The greatest difficulty that had been anticipated in designing the engine was the heat that would be developed in compressing the air; and the water was originally employed for the double purpose of carrying off the heat, and serving as a non-elastic medium for filling up the interstices among the valves, whereby the whole of the air which was introduced above the valves was sure to be expelled onwards."

The next air-engines erected were put up at the Haigh Collieries, near Wigan, in 1856. There are two engines employed in compressing the air: No. 1 being a condensing engine, worked to about 23-horse power; the compressing cylinder being worked from the end of the beam. No. 2 engine is a high-pressure horizontal one, the compressing cylinder being worked from the piston-rod, which goes through the back end of the cylinder. The engine also works a 10-inch lift of pumps about 100 yards, and it is calculated that 7-horse power is available for the purpose of compressing air. The compressing cylinders and pipes for about 20 yards are covered with water, to prevent their becoming too hot to work. The air engines are both horizontal, consisting of two cylinders each, and coupled. No. 1 engine is placed 500 yards from the shaft, and draws six trams at a time up an incline 170 yards long, the inclination being 1 in 3½. No. 2 engine is placed 130 yards nearer the shaft, and works an endless chain on a down brow, 532 yards in length, the inclination being 1 in 12. The trams are placed 20 yards apart, 26 full trams coming up and 26 empty ones going down. The compressed air is conveyed to these engines in one set of 4-inch cast-iron pipes from the surface engine. The air is compressed to 120 lbs. on the square inch at the surface, and shows the same pressure at the air-engine. The only engines of this description in this district, and, I believe, the only ones erected besides the two already named, are those at Dowlais. These were erected by a late much-lamented member of the Institute, Mr. S. Truran, the chief engineer of the works, in 1857-8, and have continued to work regularly since then.

The compressing-engine, fig. 6, is a beam-engine, with a steam-cylinder 36 inches in diameter, and with a 7-feet stroke, and is usually worked with steam at about 25 lbs.; being amply powerful enough for its present work, it is driven only about 9 or 10 strokes per minute. The compressing cylinder is the same size as the steam one. The valves are simple, and the pressure of air not exceeding 25 lbs. on the inch; no unusual precautions are necessary for keeping them and the cylinder cool, as at Haigh, where the pressure, and consequently the temperature, is so much higher; indeed, the earliest calculations seemed to have assigned too high a temperature to air at different pressures. A 30 lb. pressure was expected to give nearly enough heat to melt tin, or about 450°, whereas theory would require an effective pressure of about 120 lbs. to reach this point; and this in a cylinder impermeable to heat, which would, therefore, lose none by radiation. The maximum temperature in the air receiver of the Dowlais engine, after half an hour's work at pressures from 25 to 28 lbs., was 118° Fahr., the open air being 55°; the theoretical temperature would be about 150°. The distance from the steam-engine to the shaft is about 25 yards, the shaft itself is 175 yards deep, and the air-engines are 1000 yards to the deep of the pit; in all a distance of 1200 yards. The pipes that convey the air are wrought-iron, 3½ in. diameter. The air-engines themselves, fig. 7, are like the compressing-engine, simple and strong, consisting each of two vertical air cylinders working on the same shaft, and working four force-pumps by means of eccentrics placed upon it; four pumps can be used, but two are sufficient for the work to be done. The forcers are each 4 inches in diameter, with a stroke of 8 in., and force the water a height of 212 feet. They are generally driven at the rate of about 80 strokes a minute. The pressure of air underground is scarcely, if at all, less than at the surface when the engines are stationary, but, as in the case of steam, diminishes rapidly when they are worked; thus when the pressure in the surface receiver was 26 to 27½ lbs., that at the air-engine was 21 lbs. when the engine was stopped, and 16 lbs. only when both were working. When neither were going, the pressure, as stated before, was the same, as nearly as could be observed, as at the surface.

The PRESIDENT said that in the North of England they had already gone down very deep with some of the pits, and he believed they would also have to do so in Wales before long. How to work these deep pits, and to bring up the coal without the aid of machinery, had always been a difficult question to his mind. The paper of Mr. James was a most important and interesting one, and he should be glad to hear any observations thereon.

Mr. JAMES said that air-engines had already been tried in one or two places, and had been found to work most successfully. They had been making a tunnel through the Alps by means of a condensed air-engine, and the only difficulty they experienced was that of ventilating the tunnel—they not having taken any means for that purpose. They had got in, perhaps, about three quarters of a mile—the work was very slow, but very correct, and so far as the principle of condensed air-engines went, they had proved very successful, doing the work most efficiently.

Mr. THOMAS EVANS said, if these condensed air-engines could be brought to bear underground, it would be a most valuable discovery. The application of steam-engines underground had been found dangerous, whilst the application of water-power was objectionable, as they were obliged to re-lift the water at very great expense.

The PRESIDENT said that, in his opinion, air was the only thing which could be profitably and safely substituted for steam underground. If they could compress the air and send it some remote distance underground without any very enormous loss of power, he believed they would have the most efficient engine they could get. Little or nothing in this respect had yet been done, but he firmly believed the time would come when such a compressed air-engine would be perfected, and that it would be a material aid in the ventilation of the colliery. He considered that the day was not far distant when clever men will put them in possession of such machinery, with great advantage to the colliery proprietors, and with safety to the workmen.

Mr. COX said there could be no doubt but that this was one of the most important questions which had been brought before the members of the Institute, for he thought as they extended their workings underground that they must have other power besides that of manual and horse-power. The great question of labour was one very difficult of solution—whether it was cheaper to employ the stalwart English navigator at 5s. per day, or the Hindoo labourer at 4d., was not the question now before them, but that they must supply some mechanical power underground was evident. A steam-engine underground was decidedly bad—there was the danger of fire and many other disadvantages. Many years ago, he should think at least twenty, a Somersetshire colliery proprietor carried out a power underground which was called a "Duke," but the only way in working this was to the dip, for when they came to work to the rise they could not do it. This showed the great necessity of some mechanical power underground. The only other power which they had at their disposal was the hydraulic. This had many advantages, but it also had its disadvantages; but he firmly believed that when they had discovered some other power of lifting water rather than by pumps, that they would then use hydraulic power. Air being elastic, they had much to contend against. Practice proved that they lost at least 50 per cent. power in its use. For his own part, he was not at all prepared to say that air-engines were the only engines that could be advantageously used underground. He believed, as he had before observed, that hydraulic power would be generally used when they had overcome the difficulty of lifting the water back again. That some power must be used underground was certain, and the Institute could not be too thankful to Mr. James for bringing the subject before them.

Mr. M. MOGGRIDGE said that, perhaps, it might be interesting to those gentlemen who sometimes travelled upon the Continent to know that in the Berches Gardens of Bavaria Tyrol was to be seen the best specimen of pneumatic power in the world; the pump was there to be seen at work, and was most successful. The main principle which struck him was this:—If they had an ascending column of water, say of 1-in. diameter, and of any descent, and the pipe communicates at the bottom with a large pipe, say one of 4 in. diameter, the pressure upon the sides of the 4-in. pipe would be the same as though the whole column was 4 in. The power which was obtained by means of the pneumatic pump at Bavaria Tyrol was enormous, and he believed if any member of the Institute were within a 100 miles of the gardens they would not regret the little trouble they might have in getting an inspection of it.

Mr. FRANCIS said if Sir Wm. Armstrong could, as he had done at Swansea, open enormous lock gates, ship any quantity of coal with machinery placed at 1½ mile distant from the spot worked upon, he could not see why the same power could not be brought to bear at the bottom of a pit which was 100 fms. deep.

Mr. C. JAMES said that the same hydraulic machinery as that employed by Sir William Armstrong at Swansea had been tried in collieries, but it was liable to the objection of the great quantity of waste water, and, in fact, after fair trials, had been discontinued in consequence of the difficulty of getting rid of the waste water. Compressed air-engines had also been used, and he had not heard of a single instance in which they had been discontinued.—Mr. FRANCIS: Then what is the difficulty in their adaptation?

The PRESIDENT said that the loss of power was so very great as to prevent their being brought into more general use. If they could economise their power, they would be of great benefit.

The discussion was then brought to a close, a cordial and unanimous vote of thanks being awarded Mr. Cox for his valuable treatise.

A paper was then read written by Mr. R. SCHMIDT, on "Prof. Zenner's Diagram for showing the motion of the Slide-Valve." This was ordered to be presented, and will stand over for discussion at the next meeting.

Mr. COX said before the meeting broke up he had great pleasure in proposing a vote of thanks to their President, Mr. Lionel Brough, for taking the chair upon that occasion. They had all seen the able manner in which he had performed the duties of his office. In order properly and efficiently to discharge the duties of President, he should not only have the ability to discuss the various matters brought before them, but he should also have the kindness to encourage the timid, and the moral courage to suppress the too forward. The Institute was most highly favoured upon the present occasion with having a gentleman as President of such great experience and ability, and the way in which he had conducted the proceedings of that meeting not only reflected great credit upon himself, but upon the Institute generally. (Hear, hear.)

Mr. BEDLINGTON had great pleasure in seconding the vote of thanks just proposed by Mr. Cox. Whenever they had an opportunity of meeting their President, they always felt better and wiser for the knowledge which he imparted to them. Mr. Brough did not keep all his knowledge to himself, but was very liberal in imparting it, which list his affability and urbanity were well known to all.

The resolution was then carried with cheers.

The PRESIDENT briefly thanked the members of the Institute. His year of office now expired, and he again returned to the ranks, but whether in the ranks or whether he acted in the capacity of President, his best services were always at their disposal. He believed the society had already been the means of doing much good. Wales was essentially an engineering country. Why, the very county in which they were assembled had increased four-fold in population within the last half century. Societies such as theirs tended not only to increase their wealth, but also to the importance and magnitude of their resources. Their coal mines would never be properly developed, their iron would never be profitably made, or their copper manufactured, but for the engineering ability of such gentlemen as those present, and hence the necessity of such an institute must be apparent to all. He again sincerely thanked them for the vote of thanks just awarded him.

The proceedings then terminated, and several members of the Institute proceeded to the docks, where they inspected the pump and hydraulic machinery, and appeared highly pleased. It was stated that in case of emergency the pump could lift no less than 17,000,000 gallons of water from the half-tide basin into the South Docks!

The members afterwards dined together at the Mackworth Arms Hotel, under the presidency of LIONEL BROUGH, Esq., when various appropriate toasts were given, and cordially responded to.

MANUFACTURE OF MALLEABLE IRON AND STEEL.

Five years have now elapsed since Mr. Henry Bessemer startled the scientific and industrial world with the announcement that he had discovered a process by which iron could be manufactured without fuel; and although at that time his researches had evidently not been carried sufficiently far to warrant so bold an assertion, it cannot be denied that the iron trade is deeply indebted to him for having turned attention to a method of "nature-smelting," which will, doubtless, lead to increased economy in the production of iron. As might have been expected in the development of an invention, the adoption of which involved so complete a change in all existing notions, the difficulties and obstacles which Mr. Bessemer has met with have been almost innumerable, but with an amount of endurance and perseverance which reflects the highest credit upon him, he has surmounted them as they presented themselves, and has at length succeeded in approaching very nearly to perfection.

Amongst the latest difficulties which Mr. Bessemer has succeeded in removing is that which relates to the destruction of the tuyeres. In the manufacture of malleable iron and steel by the pneumatic process, it has been found that the powerful heat generated at or near the orifices of the tuyeres, together with the chemical action of the slags or oxides of iron and silicium, has the effect of enlarging these orifices, and in a short time rendering the tuyeres unfit for further use. The tuyeres, when thus worn, have to be replaced by new ones. The fitting in of these new tuyeres by the plan at present practised renders it necessary first to knock out the old ones, and then to cool down the converting vessel, after which the new tuyeres may be inserted in their places, and the spaces around them filled up with a plastic matter or "grout," which is generally composed of powdered "ganister" mixed with water; after this is done a fire is lighted in the converting vessel, and the wet parts thereby properly dried, and the interior of the vessel again highly heated before the process of conversion can be repeated, the change of tuyeres thus rendering the apparatus incapable of being used for several hours. The mode in which Mr. Bessemer overcomes these difficulties is by employing a form of tuyere which is capable of being replaced by others rapidly, and with little labour, as soon as worn out. His improved tuyere consists of a number of wings or discs of fire-clay, Cornish clay, plumbago and fire-clay, "silica clay," silicate of magnesia, or other suitable refractory substance; these rings have a central hole in them, through which a stout steel or iron rod passes. There are also several other holes made through them at a small distance from the central one, which holes are for the purpose of allowing air to pass through each ring, or a circular brick is put on to the iron rod, and some fire-clay or other "lute" or plastic matter is put between them so as to make a tight joint. The surfaces of each disc may be ground flat, or they may be moulded with concentric grooves, and with corresponding raised rings or ridges alternately so as to fit closely, and assist in holding each other together. A long column is thus to be built up upon the rod, the air passages in each piece being so placed as to form continuous tubes throughout the whole length of the column or tuyere. At the lower end a larger ring is put on, having other holes around its periphery communicating with those before mentioned, the upper part of the column or tuyere being surmounted with a disc larger in diameter than the rest, for the purpose of filling up the orifice in the vessel through which the tuyere is inserted. The upper end of the iron end on which the tuyere is built passes into a metal cap, so made as to be readily fixed to and form a close joint with the blast-pipe; the different pieces constituting the tuyere are pressed together by a powerful spiral spring, which allows the necessary expansion of the rod and its rings. While they are firmly held together under a regulated pressure, the lower enlarged ring in which the tuyere orifices are formed may be perforated with numerous small holes, or with a lesser number of holes of a larger size, or in lieu thereof the air may be made to escape between flat or grooved discs, or from a hollow or bell-shaped cavity formed beneath the centre of the tuyere, but he prefers to employ circular orifices of ⅛ in. or ¾ in. in diameter. For a charge of 2 tons of crude metal, forty ⅛-in. or twenty ¾-in. orifices will suffice, when the blast is used at 7 lbs. or 8 lbs. on the square inch. As a general rule, he prefers in this form of tuyere to direct the jets of air horizontally, or at a slight angle downwards, but the openings may be so made as to direct the jets in any other direction, either upward or downward, or at a tangent to the axis of the tuyere, so as to cause a rotation of the metal in the vessel. In lieu of the several air passages formed around the iron rod, one large central hole may be employed with the rod passing also down it, or several rods may pass through separate holes in the rings instead of one in the centre. Slight modifications of this arrangement may, of course, be introduced to meet the varying circumstances.

To provide for the introduction of any necessary flux or alloy into the metal under treatment a globular vessel furnished with one stop-cock between the vessel and the tuyere, and another between the vessel and the external air is employed; fluids, as well as granular or powdery matter, being introduced by this means with the greatest facility; and Mr. Bessemer also proposes to give motion to the converting vessel by means of a hydraulic ram or plunger, moving vertically in a cylinder, and placed below the axis of the vessel, the ram or plunger being raised by the pressure of water from any elevated tank or vessel under pressure, and again lowered by allowing the water to escape from beneath it; this motion of the ram is communicated to the axis of the converting vessel by means of a wire-rope attached to the ram, and passing round a grooved pulley keyed on to the axis of the vessel; a second wire-rope suspends a counterbalance weight on the opposite side of the pulley; this weight may be about equal to one-half of the weight of the ram or plunger, so that whenever the ram is raised the lowering of the counterweight will cause the vessel to turn round, while the lowering of the ram will raise the counterweight, and turn the vessel in the opposite direction. These movements will be under the control of the workman who admits or discharges the water from the apparatus by a suitable valve and handle. The vessel may thus at any time be made to discharge its contents, or be put into a position suitable for running in a charge of crude metal. In pouring out the fluid iron or steel from the converting vessel, the spout or opening from which the metal flows is moved (as the pouring proceeds) away from the spot where the pouring first commenced; the casting crane is, therefore, provided with a suitable sliding motion. Both cast-steel and malleable iron, when in a molten state, frequently disengage gases so rapidly as to flow or boil over the tops of the moulds in which they are poured, and thus form ingots or castings containing numerous cells. Mr. Bessemer has now found that this tendency of the metal to disengage gases and boil spontaneously is counteracted by the employment of a very small quantity of the metal silicium, 1 lb. in weight of which is sufficient when diffused through 2000 lbs. of molten steel to destroy this tendency to ebullition, and cause the metal to lie quietly in the mould.

About the year 1839, Josiah Marshall Heath discovered that metallic manganese also had a powerful effect upon molten steel if alloyed therewith to the extent of 1 per cent.; he found that it conferred on the steel so alloyed the property of welding and working more soundly under the hammer than steel not so alloyed. The result of this discovery by Heath has been the almost universal application of manganese to the manufacture of cast-steel. It, however, happens that both the metals silicium and manganese are difficult of reduction in such quantities as are required for commercial purposes, and when found naturally alloyed with iron the latter metal is in such excess as to cause many disadvantages in its use in alloying steel with those metals. But Mr. Bessemer has found that the metals manganese and silicium may be readily reduced in combination with so small a quantity of iron as to facilitate their application instead of causing an inconvenience by any excess of iron or carbon present, as in the natural alloys of these metals with pig-iron. For the purpose of making an alloy easy of reduction from its ores or oxides, and especially suitable as an alloying metal, he takes by preference from 30 to 70 parts of pure hematite or magnetic iron ore, and 50 parts of grey or black oxide of manganese; or he takes manganesium iron ore, and adds to it as much grey or black oxide of manganese as may be desired, and if silica be not present in these oxides, he adds five parts of powdered flint, or such quantity of a silicious iron ore as is equivalent thereto; to these materials he adds about 40 parts of pure anthracite coal, or other pure, or nearly pure, carbon; he then crushes these materials under edge-stones, or between crushing rolls; the materials thus become thoroughly mixed and incorporated, and may then be deoxidised or cemented in fire-clay retorts, such as are used for gas making, or in the chests of an ordinary steel-converting furnace, and after cooling down may be sprinkled with or immersed in coal tar, or other hydrocarbon, preparatory to the smelting of the metallised mass in crucibles, and which crucible he by preference fixes in an air-furnace, where they may be surrounded with coke, as practised in furnaces employed to melt blister-steel; or the furnace may have tuyeres around the lower part, and be urged by a blast. He places the crucibles on a stand which has a hole through it; the crucible has also an opening in its lower part, so that the cemented metallic mass as it fuses may flow or be tapped out, and fall into a trough or mould, while more of the materials are put in at the top, so as to render the operation continuous, like a blast-furnace, so long as the crucible lasts. The preliminary process of deoxidising the ores in retorts or chests may be omitted if the melting crucibles are made sufficiently high, or have rings of fire-clay built up upon them to increase their height, so that the crude materials may be put in at the top and become gradually deoxidised as they sink down, or the materials may be formed into masses by pressure in suitable moulds previous to the deoxidising or smelting process. The metallic alloy so made may be heated or melted in other crucibles when required for use. From 30 to 50 lbs. of this alloying metal may be put into each ton of molten steel before pouring the same into moulds; but when he desires to use this alloying metal (or any other similar mixture of metals containing carbon) in the manufacture of malleable iron, or in the manufacture of very mild or soft steel, he casts the said alloying metal into thin plates, or he granulates or "shots" it, after which it is to be decarbonised, or partially decarbonised, by cementation in boxes or chambers containing oxides of iron or zinc, so that the iron present in the alloy may be converted into malleable iron, and be thus prevented from re-carburetting the malleable iron, or mild steel, into which it is put in a solid, though highly-heated, state.

It is obvious that these methods, although described only in their application of metallic oxides, and to the forming of alloys of iron and manganese, or iron and silicium may also be employed in forming alloys of iron with any other known metal capable of uniting or alloying therewith, provided that such metals are of a nature to be reduced for their oxides, acids, or salts by the action of carbon at a high temperature; Mr. Bessemer, however, desires it to be understood that he lays no claim to the production of any such alloys, nor to their employment or mixture with malleable iron or steel.

MANSFELD COPPER-SLATE MINES IN PRUSSIAN SAXONY.

BY W. P. JERVIS, F.G.S., MINING ENGINEER.

In ancient times small pits were sunk, and the moment water accumulated to any amount, so as to render pumping difficult, a fresh one was begun; they, however, only proceeded to a very inconsiderable depth, leaving the best parts of the basin untouched. This antiquated system has been long superseded; the drainage of the Eisleben basin has been effected by seventeen distinct adits. The principal is the Schlüssel level, not yet completed, though already thirteen miles long. The finished portion extends from Gottesbelohnung to Burgörner, Gerbstedt, and thence to the Schlenze at Friedeburg on the Saale; another part is completed between Wimmelburg and Helbra. The object of this stupendous undertaking—certainly one of the most remarkable engineering works of the kind in existence—is to form a common outlet for the waters of the mines at the Saale. The adits follow the copper-slate, as far as possible, at given depths, being generally so contrived that the upper two-thirds lie in the slate, and the remainder in the *Liegendes*, in order that the water may neither incommode the miners nor flood the ore in the direction of the dip.

Of about forty shafts, employed for the use of the miners and extraction of the ore, the majority are convenient and spacious; they are rectangular, and divided into three parts, one for the ladders and pumps, the others for the wagons, which are placed on platforms. The quantity of water in the higher levels is considerable. Herr Richards, the inspector of the machinery, has lately devised a very beautiful and simple contrivance to supersede the use of steam, which, from its great economy, deserves attention; this he calls a hydraulic balance. It consists of a pair of rectangular boxes, formed of thin boiler-plate, firmly bolted and water-tight, 6 ft. by 4 ft., and 2½ ft. deep; they are kept in shape by four longitudinal and four latitudinal bars, and are suspended by a light iron frame, and connected at either end of a wire-rope with the drum. To raise the ore the vessel is filled with water by a hose at the surface; it then sinks by its own weight through the shaft to the lowest level, drawing up the empty case and a wagon of ore attached to the opposite end of the rope. Nothing can be easier than the management of this balance; a man stands by the break and gives the necessary freedom of motion, he can instantly stop the case in its descent, and as easily set it in motion again. From 6 to 7 centner of ore are raised each time in a little wagon placed on a platform over the balance. The water is at once emptied from the case by raising a valve at the bottom. After deducting the trifling expenses of the building, balances, and drums, the cost of keeping up is inconsiderable, certainly not 2s. 6d. a day.

Noberge or *Dachberge* (sometimes subdivided into *Schwartz* and *Grauberge*), bituminous limestone, and region of "roof-ores" (*Dacherze*), 8 in.; *Schieferkopf* ("head"), 3 in.; *Kammschale*, 1 in.; *Grobe* and *feine* (*Lette*), 3 in.

The ores are chiefly sulphuretted combinations. Thus, the cupriferous beds are locally 15 to 16 in. thick; the *Klotz* being removed gives a height of about 21 to 24 in. to the workings. The most careful ocular examination would often fail to show any metalliferous particles in the lowest bed, which is soft, and rather assumes the appearance of fat coal, and may be cut with a knife. This earthy substance is very inconstant, and often absent. In other places it is seen above or in the *Lette*, the most important member of the copper-slate formation. The *Lette* is divided into fine and coarse; the former, or lower variety, is a blackish slaty rock, marked parallel to the planes of stratification, with an infinite number of minute particles of ore, either bright yellow copper pyrites, gray or purple copper, copper indigo, or cupriferous iron pyrites. It often contains several thin plates of horse-flesh ore and vitreous copper, ⅛ to ¼ in. in thickness, between the planes of stratification, also thinner streaks of copper pyrites. The *Kammschale* is distinguished by the delicate white hair-like streaks which alternate with the black ground; these are not continuous, but about an inch long, and chiefly composed of sulphur. The *Schieferkopf* is a more uniform slaty bed, without the delicate metalliferous particles of the *Lette*, or the streakings of the *Kammschale*: it frequently contains ore between its layers. Ore in the *Dachberge* generally consists of concentrated masses of purple copper ore, as large as a bean, in the midst of very bituminous limestone. The *Dachberge* is supposed to cover the ores as a roof; the ores obtained from this roof are termed *Dacherze*.

Mr. Jervis considers the siliceous ores to be of secondary formation, and produced at the expense of the copper-slate by the infiltration of water, &c. Throughout the Eisleben basin the sand ores are very scarce, and only met with in one restricted spot near Erdmann shaft. The general north-west and south-east strike of the rocks is accompanied by a vast number of parallel dislocations of the strata, continuous in proportion to their vertical fracture. The principal fault in the Eisleben basin is 15 fms. deep; it runs for a considerable distance north-west and south-east, in the direction of the strike. This fault, being so important, rendered the construction of the level north of Erdmann shaft very expensive, apart from the necessity of carrying it for some distance through sterile sandstone. When in direct contact with the copper-slate a polished surface is generally produced by friction, and a trace of ore is usually met with. Galena is frequently found in the *Dach*, in the immediate neighbourhood of faults; also nests of heavy spar, accompanied by copper-nickel, for the distance of several yards on either side of the fault. Where abundant such dislocations have produced a beautiful plication on the hard *Lette* and *Schramm*. The folds observed at the Martin shaft have a continuous denticulated appearance; the black *Schramm*, on the other hand, has very polished curved surfaces, generally coated with copper pyrites, purple copper, and more rarely native silver.

The mode of laying out a *Kupferschiefer* mine is entirely peculiar. The shafts proceed at once to the adit, and thence to the copper-slate bed, where they invariably terminate; a level is made in the direction of the strike, with sufficient rise to effect the drainage. At a convenient point an inclined plane is formed in the direction of the dip, ascending or descending perpendicular to the level. It is a custom to make parallel levels start from these at uniform distances. The levels are roomy and airy, but the inclined cross-courses have to be made much wider, to admit of a double tramway, for the passage of wagons attached to a wire-rope, and set in motion by a subterranean steam-engine. Sometimes the uppermost wagon of the descending train is fitted up as a cistern, and filled by a hose; this draws up the full wagons to the level of the bottom of the shaft, and the water is let out into the adit. Such an arrangement is used with great success at several shafts, since there is abundance of water at the higher part of the mine. The inclination of the cross-courses entirely depends upon that of the strata, as the floor is invariably formed by the sandstone, and the roof made at the expense of the limestone above.

The preliminary openings being completed, the ground is laid out among gangs of miners, who commence the entire extraction of the copper-slate. The rock thus undermined would at any moment threaten the lives of the men, and the utter obliteration of the levels, but for a most ingenious device. An equal space of ground is systematically planned out on either side of the cross-course, in the form of a very acute isosceles triangle, the base of which corresponds with the level. The triangle continually expands by parallel increments, but is always bisected by the cross-course, whereby the pressure of the roof continues to be equally distributed on either side. The local thickness of the cupriferous beds, 15 to 24 in., represents the height of the workings. The miners work in a reclining position, resting on their left shoulder. They are placed as close as possible, the feet of the one above the head of the other. Billets of fir are driven in to support the roof, and columns of rough stone. As the space increases it is filled in with rubbish and worthless slate, carefully built up; eventually the whole roof quietly settles down, only sinking a few inches by the compression of the stone work, and not impeding the men. The few feet adjoining the actual work is always left free for the passage of boys who drag out the ore to the levels in little wooden boxes attached to their waist. One lad is allotted to so many, who are distinguished into miners and apprentices. The ore which each gang of men extracts is kept by itself until the end of the month, when it is examined by the captains, and they are paid accordingly; but the wagon-lads have fixed wages. This constitutes a two-fold classification into tribute-work and work for wages; with the former class a fresh contract is made every month. When the ore reaches the surface it is distributed among a number of elderly men, to be broken up and sorted.

The mines at Sangerhausen are worked high above the valley at the edge of the basin; the beds inclining towards the Goldene Aue, the drainage is far more easily effected than

near Eisleben. Few shafts are at work, and those on a scale, between Morungen and Gross Lemungen, five or six miles above Sangerhausen. The mines have been generally worked independently of the rest, and were only acquired by the Mansfeld Company in 1834. The chief workings around Carolus and Johannis shafts are connected together internally. Drainage is effected by the Segen Gottes level, the entrance to which is above Sangerhausen. Two-thirds of the ore is here found in the sandstone. The slate is not always remunerative in itself, but the slightly cupriferous Dach and Kopf are extracted from lack of better materials as a flux. The siliceous ores are 1½ to 2½ inches thick, of which the upper one is rich, containing 10 per cent. of copper; the rest is poor, not exceeding 5 per cent.; they are separated for the convenience of roasting, and then stamped. One or two important faults run through the sett, accompanied by rich masses of copper-nickel now largely extracted, occurring on both sides of the dislocation, disseminated in the most complex manner in heavy spar. A singular history is told of a pit which had been worked for copper-slate, when improvements in the art of smelting proved that the highly siliceous ores could be turned to advantage without loss in the slags, so the whole ground was laid open again. The shaft and levels are now in operation for the third time along the fault to extract the copper nickel. In 1859 the quantity of copper-slate and sand ores extracted from the Mansfeld Mines was 47,214 tons.

	Per cent.	Silver per ctr. of refined copper.
Rich sand ores from Carolus shaft yield about	10·0	
Poor ditto	5·0	
Workings near Kloster Mansfeld	5·0	Loth Gran.
Workings below the Schlüssel level yielded, 1857	3·86	18 4·63
Thirty-fifth ventilating shaft yields about	3·16	
Workings near Helbra	2·5	
Workings near Wimmelburg	2·0	
Hornickel shaft yields	1·5	

Average produce throughout these mines:—

Upper Reviere	2·75 to 3·75	16·32 to 22
Upper Reviere, occasionally	4·0	
Lower Reviere	2·0 to 4·5	14·5 to 17

2½ per cent. is considered remunerative for slate, 5 per cent. for siliceous ores. The average amount of silver is 15 loth per centner of refined copper, or 1·200.

METALLURGY.—1. Roasting: The bulky copper-slate is roasted for six weeks to a quarter of year in oblong mounds, containing 300 to 1000 tons of slate. Faggots of beech or other hard wood are first laid on the ground to the depth of a foot, above which the slate is loosely piled to allow the passage of air; in proportion as the water is driven off, the sulphur and bitumen of the ore serve to keep up the combustion; too great activity is prevented by adding fresh quantities of ore wherever flames break forth. The slate becomes foliated and friable by the loss of the water; the calcareous strata lose their carbonic acid; part of the clay combines with any oxide of iron present, appearing like badly baked brick; much of the ore is oxidised, while the rest forms a more concentrated sulphide. At the conclusion of the roasting the men separate the under part, which has been sufficiently subjected to the action of fire, from the upper; the latter is put on a subsequent heap to be re-roasted.—2. First fusion in a cupola furnace. The roasted slate is thrown in at the summit of the cupola; thence it falls into the short cylindrical prism, communicating directly with the kiln, in which fusion takes place. The lowest part of the furnace is entirely constructed of refractory bricks and stone. The furnace is built in a massive manner, so as to appear square at the exterior. The proportions adopted for a furnace charge depend much on the nature of the ore. The roasted calcareous slate is mixed with convenient proportions of coke, fluor-spar, and slags from the preceding operations, as well as from the manufacture of concentrated matt and black copper. Having gradually descended, and then subjected to a very elevated temperature by the ordinary blasts, the sulphuretted copper ores tend to become concentrated into a mass, easily separating by its weight from the lighter slags the fluor-spar, at the same time forming gaseous combinations, which go up the chimney. A tap-hole is now forced open, and the matt flows out into an hemispherical basin in front of the furnace. During the time that the products flow in this manner into the basin, the slags are removed 15 to 20 times. The lower part of the slag is opaque red, being highly cupriferous, and is set aside to add to subsequent charges. The basin being filled, the first plughole is stopped up with clay, and the other one opened to fill the remaining basin. The first matt ranges from 23 to 58 per cent.

The ores at Sangerhausen are chiefly siliceous, and highly refractory. They undergo preparatory stamping, and are freed as much as possible from quartz by washing on a percussion table. Good limestone is wholly unprocurable in the neighbourhood, but is partly substituted by the Dach, notwithstanding which it may be observed that far more fluor-spar is employed than at Eisleben or Mansfeld. The blast is here heated to about 325° Fahr.—Second Roasting: The broken-up matt is roasted for a fortnight in little bins. The once-roasted matt contains lumps scarcely distinguishable from natural grey copper ore; the rest simply clots together, and is tarnished like purple copper ore. After it has all been broken up by boys, the least changed part is removed to the adjoining bin, and once more roasted with a fresh quantity of wood. The product is twice roasted richer matt. The same operation by lads of communition and sorting is repeated on the richer matt in the enclosure itself.—Treatment of the Roasted Matt in Reverberatory Furnaces to complete the formation of a Pure Matt: These furnaces have a rectangular base 14 ft. by 20 ft., and are 5 ft. high. After two charges the matt, an almost pure disulphide of copper, is allowed to fall into water, whereby it is reduced to a fine state of division, like shot, and subsequently ground under heavy millstones, greatly expediting the separation of the silver.—Desilvering Process: For merly the silver was separated from the copper by means of lead. The liquation process was very expensive, where such prodigous quantities of copper have to be treated. At the commencement of this century amalgamation with mercury took the place of the tedious method of alloying with lead. This was still a most complicated affair, and required a very extensive apparatus, much machinery, and, above all, much expensive mercury. It is only within the last 12 or 14 years that Messrs. Augustin and Ziervogel devised anything at all suitable for the desilverisation of the ores. The salt process was at once adopted at the Gottesbelohnug works, and was a great step in advance. The concentrated matt was roasted in a reverberatory furnace, by which the sulphides were converted into their corresponding sulphates; but at the very elevated temperature required for the formation of sulphate of silver the others were again almost entirely decomposed into peroxide of iron and oxide of copper, with the evolution of sulphurous and sulphuric acids. The sulphate of silver and any remaining sulphate of copper were at once treated with salt thrown into the furnace. The products where chlorides of silver and copper, and sulphate of soda. The chloride of silver was then treated with a hot saturated solution of salt, by which it was dissolved, and precipitated by copper.

The salt process is still employed in Saxony, but here all the matt is desilverised.—Ziervogel's Water Process: The concentrated matt is finely ground and introduced into the reverberatory furnace, where the complex sulphides are allowed to oxidise. The furnaces have two floors, the matt being introduced into the upper one, and continually raked about to expose fresh surfaces to the action of the air; the flame does not enter the floor, but only circulates round it. On removal from the furnace the sulphate of silver, being soluble in water, is at once separated from the oxides of iron, copper, nickel, zinc, &c. The whole charge is distributed in vats, and boiling water poured into them. The sulphate of silver with any traces of sulphate of copper speedily dissolves and runs out of the perforated bottom, on which are placed in succession several sized sieves. The solution flows through a pipe into a lower series of vats, containing black copper; chemical decomposition immediately ensues; the sulphuric acid attacks the bars of copper, which rapidly disappear; the silver is simultaneously liberated as an impalpable mud of cement silver. After 24 hours the liquid has settled, and the vitriol is drawn off with a syphon into a third row of vats, coming in contact with fresh copper. The silver is thoroughly washed previous to being smelted in a small reverberatory furnace.—Treatment of the Copper Residue of the Desilverising Process: The insoluble residue of black oxide of copper is made up into balls with clay, and spread out on racks arranged round a drying chamber before they are ready to charge in a little blast-furnace, similar to those employed for smelting the ores. Twenty-four hours' treatment with coke and fluor-spar yields black copper pretty free from arsenic and antimony, containing from 88 to 92, rarely 95 per cent. of copper, with 17 to 18 loth of silver per centner, and a matt with from 50 to 60 per cent. of copper, and from 6 to 8 loth of silver.—Smelting the Black Copper and Refining, either in Hearths, or, as in England, in Reverberatory Furnaces: The hearth is a simple hemispherical hollow, on which a pair of bellows can play. The black copper is thrown in in fragments, to which is gradually added soft charcoal, to combine with any oxide in the black copper, and convert the carbonic oxide into carbonic acid; after two or three hours the metal is entirely liquified, and the refinery scum removed. The men quickly throw a bucket of water on the bath to cool the surface, and proceed with a thin shovel to lift off the thin plate of copper which has been consolidated; the temperature is not allowed to descend too rapidly, but just so as to give time for the successive removal of plates of metal.

THE MINERAL WEALTH OF SOUTH WALES—No. V.

THE TAIAU BACH MINE.

Llwyncalenig farm-house lies upon the breast of a hill, and directly opposite rises somewhat abruptly Alt-y-walis, at whose base a rivulet forces its devious way in the direction of Llanpumpsaint. The valley opens pretty nearly east and west, and on the southern slope are the Llwyncalenig Mines, which we recently described. About a mile to the north-west the little stream has exposed five lodes running east and west through Taiau Bach farm, the property of Mr. W. G. Stedman Thomas, of Oak House, Carmarthen. These lodes were observed several years since by a tenant of the farm, who, from the quantity of metalliferous stones met with in his agricultural operations, was led to conjecture the presence of mineral veins. When he discovered them they were at once pointed out to Mr. Thomas, but he would not speculate, and they remained untried until last year. It was then suggested that a local company should be formed to work the lodes, under the direction of a good practical miner; and we have no doubt it could have been done, but Mr. Thomas preferred first of all sinking a trial-shaft, in order to ascertain the value of the mine, before involving himself in the trouble and expense of getting up a company. About sixty persons, willing to take shares, subscribed a sovereign each, and Capt. Toy, late of the Carmarthen United Mines, was instructed to sink on the lodes. A cross-cut was made a few yards south of the outcrop, opening the back of the widest lode, which in this place was composed of quartz and clay-slate, with an abundance of fine gossan. Capt. Toy selected a capital site for the shaft, about ten yards from the cross-cut, and commenced sinking. There was some difficulty in cutting the tough clay-slate; and the whole valley being very moist, and traversed by a mountain stream close to the pit, the water was found heavy for hand-work, and when a depth of 20 ft. had been attained the small capital provided was entirely spent. Mr. Thomas then considered it advisable to stop the works, as there were other unproductive mines in operation, which he did not wish to embarrass. But before abandoning them he instructed Capt. Henry Francis to inspect the lodes, and in his report he says:—"In giving you my opinion respecting the mineral features of Taiau Bach, I shall confine my remarks to a channel of mineral stratification near the farm-house, which a rivulet has exposed to view, and in which there are a tribe of veins running east and west, mostly composed of spar, deeply stained with gossan. When first the veins were shown to me I was not disposed to think favourably of them, as there were no traces of mineral; but the trial made convinces me that in depth there is every probability of their being highly productive. My reason for coming to this conclusion is, that in the trial-pit and cross-cut from it, 4 fathoms below the surface, the stratification assumes a very mineralised appearance, and the lodes are strongly spotted with copper and lead ores. It well deserves a spirited trial, and I should recommend that a shaft be sunk 30 fms. or 40 fms. deep, and that cross-cuts be made from the bottom of it to prove the lodes." Capt. Matthew Francis also reported upon these mines; he says:—"I found the lodes to consist principally of quartz, showing specks of both lead and copper, attended by a large issue of water, and having a regular bearing and underlie, with a good flookan, which form the usual indications towards the surface of a body of ore below. Your operations are not deep enough to disclose the ore ground; your trials are, however, in a new mining country, which all who possess land in the neighbourhood are interested in exploring. You cannot sink deeper by means of hand-labour for draining the water, but a small balance-engine, or a small water-wheel, (say) 25 ft. diameter and 4 ft. wide in the head, with a column of 6-in. pumps, (say) at a total cost of 500*l.*, would enable you to go down to a depth of 50 fathoms from the surface, where there is a fair chance of getting into the ore ground. I, therefore, advise you to form a company, in order to give the mines a fair trial, and I think you will not be disappointed in meeting with a valuable body of lead ore." Capt. Toy also speaks highly of the indications, and recommends a further trial. His opinion carries great weight, because he assisted in the trial, has had many years' experience, is an excellent practical miner, and honest to a fault.

We visited these mines last week, in company with Mr. Thomas and Mr. Davies, the proprietor of Llwyncalenig. The stratification of Taiau Bach, like that of Llwyncalenig, is argillaceous; in some places soft and shaly, and in others hard and fissile. Its dip varies from an angle of 60° to 90°, and the strike is nearly from north-east to south-west. There was a good deal of water in the stream, but it was beautifully clear, and the ridges of hard quartz were seen rising distinctly above the softer rock of the country. There are five lodes crossing the stream a few feet apart, and running east and west, with an underlie of about 60° south, while the strata at this point dip north-west, and are traversed obliquely by the lodes. Capt. Toy believes these to be the outcrop of one lode, split into several limbs near the surface, and there are sound reasons for that opinion. The largest outcrop is about a foot wide; the others are not quite so large. The lodes where exposed consist of quartz, coloured with the sesquioxide of iron, and angular pieces of clay-slate. The quartz is massive, and broken into cubes of various sizes. The cross-cut being full of water, we could not see the back of the lodes in it, but the filling matter thrown up consists principally of dark clay-slate and lumps of quartz, spotted with iron and copper. We also found the shaft full of water, but the stuff on surface showed the nature of the lodes. Some of the quartz here is highly crystallised; the greater part is, however, massive and of a kindly sort, cellular and occasionally pulveruient, and the harder pieces contain sulphide of iron, copper, and lead, and the clay-slate disintegrated by exposure is rich in protoxide of iron. There are also in the veins many siliceous stones, and, we are assured, in depth they gave carbonate of lime, but we saw none of it.

To understand the condition of another lode south of these we must return to the brook under the brow of Alt-y-walis, and near Llwyncalenig. The outcrop in this place is made distinct by the water, which has carried away the softer clay-rock to the depth of 4 or 5 ft., leaving the lode like a reef in the bed of the river. Mr. Davies, of Llwyncalenig, discovered this lode several years ago when fishing, his tackle having got entangled in the knotted roots of a tree which found sustenance in the lode. He soon afterwards sunk a trial-pit sufficient to prove it, and found that it consisted of sulphate of baryta, quartz, clay-slate, and stones of lead ore. The lode underlies north, and is not of much value to Mr. Davies, as it penetrates the land of Sir Erasmus Williams, which is separated from Llwyncalenig by the stream we have mentioned. Nothing more has since been done. This lode runs east and west, and dipping north it must cut Mr. Thomas's lode about 500 yards south of the Taiau Bach shaft. We have thus in the valley extending from Llwyncalenig to Taiau Bach a group of lodes presenting at the outcrop all the indications usually seen in the western counties of Wales of valuable ore ground; in fact, there can be no doubt of the metallic character of the lodes; we speak now of both those at Llwyncalenig and at Taiau Bach, but they cannot be developed by a local company. The Welsh, as a people, are dead to all industrial enterprise. Their iron and coal works are carried on by Englishmen; their ports owe the prosperity they enjoy to strangers; their railways are made by men who have no personal connection with the district; and their mines are managed by some of the great firms, which rarely have Welshmen associated with them. We are forced to speak the truth in this matter, and the rough shock it gives may, perhaps, startle a Welshman here and there into active enterprise. It is a fact that most of the Welsh mining ventures fail until taken up by Englishmen,—fail absolutely for lack of energy and perseverance. Such is the case at the Taiau Bach Mine; a few pounds were spent in sinking a trial-pit, which was abandoned long before it was deep enough to cut the back of the lode, although that was the object contemplated; and it would be a terrible task to prevail upon the people who live in the district to resume the works. This ore ground, then, however valuable, will remain untouched for an age unless some of the great mining companies develope it; and they would find both Mr. Thomas and Mr. Davies ready to meet them in a liberal spirit. The mines at present could be leased at an extremely low rate, and every facility given for the works. We should also mention that very shortly there will be a railway station within a mile of Taiau Bach; the line is already open to within four miles of Llanpumpsaint, and will in a few months be completed to that village.

MINING IN AUSTRALASIA—MONTHLY SUMMARY.

MELBOURNE, JULY 25.—The quantity of gold brought down by escort to the 20th inst. is considerably less than during the same period last year. The total quantity is 1,015,564 ozs., valued at 4,062,256*l.*, against 1,122,078 ozs., valued at 4,488,312*l.*, showing a decrease of 426,056*l.*, while the shipments during the same period show an increase. The quantity shipped to date is 1,120,976 ozs., valued at 4,483,904*l.*, against 1,093,730 ozs., valued at 4,374,920*l.*, to the same date of last year, showing an increase of 109,024*l.* sterling.

We have no movement of much importance to narrate during the past month, although an occasional small rush has taken place in the Pyrenees district; one being to the head of Wattle Flat, about a mile from Hind's Station; and another to Peter's Station, where the sinking runs about 30 feet, and the yield averaging about ½ oz. to the load. The event of most importance in this district was the raising of some very rich stone from the prospector's claim on the Pyrenees Reef. Although the quartz only filled two boxes, it was computed to contain 35 lbs. weight of gold, and the average yield of the reef is calculated at 300 ozs. per ton.

The intelligence from the Forrest Creek district is of its usual character; some of the claims on White Horse Reef are yielding satisfactorily. On Monday last a nugget weighing 1 lb. was found by a party on Windlass Hill, and another of 24 ozs. about the same time in Poverty Gulley. A parcel of 5 tons of stone from North and Co.'s claim produced 19 ozs., and a parcel from a neighbouring reef averaged 3 ozs. per ton.

The Old Inglewood Deep Lead continues to improve; the gold is becoming heavier, giving increased encouragement, and many new shafts are going down. The Columbian Reef continues to give good stone, one parcel of 100 tons producing 489 ozs., and another of 137 tons yielding 533 ozs. of gold. The last accounts from the Benalla Reefs are good; some of the quartz now being raised is estimated to yield 6 ozs. per ton.

The Crooked River Diggings, Gippsland, begin to attract more attention. A claim has been taken up within six miles of Bushy Park, and another is spoken of on the high ground of Eagle Hawk Station. Nothing can be more plain than that an extensive gold field exists on the tributaries of the Glengarry, Avon, and Mitchel.

Several of the Ballarat companies have been revelling in good returns and large dividends. The Cosmopolitan declared a dividend of 70*l.* per man for the week's work; and the "Sons of Justice," at the Bald Hills, have divided 300 ozs. between ten men during the month.

At last a discovery worth boasting of has been made by the Avoca Reef hunters in Iron Bark Gulley, Homebosh, of a reef 3 feet thick, and containing gold equal to 20 ozs. to the ton. And not only are the prospectors thus fortunate, but in the claim opened next to theirs still better stone is reported to have been struck. A promising new reef has been opened at the Amphitheatre, where there have been also two rushes to alluvial ground of more importance than usual.

A circumstance of the utmost importance to the mining community has been the action taken by the Government in offering to lease any quantity of land under 20 acres to a single individual for a term of seven years, at a rental of 5*l.* per acre for two acres, and 5*s.* per acre for any additional quantity up to twenty acres. So eager have the miners in Ballarat district been to take advantage of it, that hundreds of applications have been made, exceeding 57,000 acres in area. So popular is the move that there is every probability of the Government not only increasing the quantity, but materially reducing the rental. Every leaseholder has the option of purchasing, at the upset price of 1*l.* per acre, at any time during the lease, having made certain improvements.

C. LEICESTER AND CO., Mining Engineers.

KAPUNDA.—Owing to the continuous wet weather, further portions of the ground in the old workings had given way, and the current month had been chiefly devoted to clearing and securing the shafts to enable the tributers to bring the ores to surface, where also the ore floors had been very much damaged by rain, and had caused great delay in dressing the ores. A very good branch of rich grey and black ore, of about 50 per cent. produce, had been cut in the 60 fm. level cross-cut, driving east, which is confidently believed to be the orey part of the main lode; but the water giving trouble (though under control), it was considered prudent not to open on the lode for the present. The May ores were 287 tons, of 18 per cent. average produce, equal to 52 tons of pure copper; the yield for June was estimated as also about 287 tons. At the smelting-works, Nos. 1 and 3 furnace had been under repair, and the chimney stack of No. 6 was being rebuilt, and when the weather permitted a fair supply of fuel was being obtained: 34½ tons of copper had been shipped per *Swiftsure*, Melbourne to London: 13½ tons had been shipped per *Oscar*, to Melbourne for transhipment, and there were about 60 tons at the port and in store, waiting freight, which at the moment it was difficult to obtain.

GREAT NORTHERN.—The committee at Adelaide report—"It is with much pleasure we call your particular attention to Capt. Pascoe's report, No. 15, by which you will perceive the operations on the company's properties are going on vigorously, and attended with the most cheering prospects as to ultimate results. The report comprises such full details that we have considered it unnecessary to recapitulate them. The committee have found no opportunity for making another shipment of ore, but are in treaty with Messrs. Elder and Co. and Stilling and Co. to secure freight in the wool ships loading at Port Augusta." Capt. B. Pascoe (Nuccaleena, July 19) reports—"Mooroo Mine: We have cut the lode about 10 fms. to the south of our present working; the lode is 3 ft. wide, good for copper ore of rich quality. We have now ore ground in this mine 25 fms. long, and we may calculate upon having a rich and lasting mine here. We have already commenced carting ore to the port from this mine.—Oratunga Mine: We are sinking a shaft, and driving a cross-cut to cut the lode below the slide, and have six men stoping ground for ores. We have sent down three drays loaded with copper ore from the mine, and shall send two others in a few days.—Wheal Stuart: In cutting across the lode we find it 12 ft. wide; 6 ft. of which is as good a lode of gossan as I ever saw, and the stratum as good for producing copper ore. I think we shall get rich ore below the gossan.—Nuccaleena Mine: The lode in the 10 end, east of D, is 7 ft. wide, of copper ore and barytes mixed; no south wall as yet; ground hard, and water hot. We are sinking a winze 10 fms. east of the winze C in the bottom of the deep adit to communicate with the 10; winze down about 5 fms. to the side of the lode, and the lode good for ores; width unknown. The lode in the deep adit end is 6 ft. wide; the lode in the south part of section 2 is good for ore, 6 ft. wide; the lode in section 6 is 6 ft. wide, producing good ore; and the lode in the middle adit on section 5 is good for ore. Since my last, I have sent from this mine to the port about 86 tons of copper ore, from Oratunga Mine 8 tons, and from the Mooroo Mine 5 tons, and hope to raise from this date to the end of December next 1000 tons from this mine alone. We have about 200 tons of ore at the surface at the Nuccaleena Mine, and about 20 tons at the Mooroo, and also 20 tons at Oratunga. We shall get our cartage done for much less shortly, as there are so many dray drivers asking for cartage of ore, and there is now plenty of feed for cattle."

NORTH RHINE.—Capt. Barkla reports—"The shaftmen have commenced the sinking of Cope's engine-shaft below the 43. The stratum of ground in the shaft is good, and likely to continue for some depth, and I expect the shaftmen will strike the main lode in sinking the shaft about 3 fms. further, and if this stratum of ground continues there is every reason to expect a good orey lode when cut, for there is every indication of ore in the stratum of ground that the men are how sinking through. With regard to claim No. 494 (Wallaroo), Capt. Lean has been instructed to sink a shaft immediately on the course of the most promising lode; and at the same time to continue cleaning through the section. He has also been requested to forward a plan showing the workings on both claims, 493 and 494. I trust in my next to be enabled to give you a favourable report upon this property."

WORTHING.—Legg's engine-shaft had been sunk 9 ft. 6 in., making the total depth 9 fms. under the 33; ground without change. The 33 south had been driven 7 ft. 8 in.; the portion of the lode taken down being good dredge work, and an improvement in the ground for driving. Hocking's shaft had been sunk 8 ft. 2 in.; ground hard, and in the present bottom not so good for ore as it had been. The stopes (No. 1 winze) in back of the 23 had yielded well during the month, and would still yield large quantities of rich ore. The 23 south had been driven 5 fms. 2 ft. 3 in. through a lode varying from 18 in. to 3 ft. wide, of rich ore; the ground favourable for driving. The stopes in bottom of the 10, about Hocking's shaft, had yielded some good fine black ore, and several tons of coarse dredge work. Quantity of ore raised, dressed, and put to pile during the month was 93 tons, equal to 12 tons of copper. Quantity shipped, per *Swiftsure* and *Anglesea*, equal to 38 tons of copper, leaving total on hand equal to 31 tons of copper. The quality of regulus now shipping was better, equal to 50 or 55 per cent.

BON ACCORD.—Capt. Jeffery reports that, in addition to the favourable change which took place in the lode at the depth of 40 fms., the general character of the ground in sinking the last 10 or 12 fms. to the depth of 50 fms. in engine-shaft had much improved; and adds, "as regards the progress making in driving the 50, west from engine-shaft, to cut the winze lode, I think we are getting near the lode; the ground is harder, and stained with ore." The Chairman of the committee writes:—"Since my last respects the sinking and driving have progressed rapidly, the ground being of a very kindly character. A few more days will decide the question as to the extent and richness of the lode at the 50."

WHEAL ELLEN.—The steam-engine, boiler, and pumpwork were in course of delivery at the mine, and the erection of needful furnaces was to be proceeded with so soon as the fire-bricks were ready for use. The men were engaged in enlarging and timbering Corkscrew shaft, which is to be the future engine-shaft of the mine. The restoration of the dressing-floor was completed, and the stamps at work. The following report from the mine refers to a discovery of copper, to which the colonial committee attaches importance—"I beg to hand you further information respecting discovery of copper ores at the bottom of the north shaft. The shaft has been sunk from surface to the depth of 26 fms.; in the first 23 fms. the lode is composed of gold, producing iron, gossan, and carbonate lead ore, varying from 2 to 10 feet wide. In the driving of the 11 south stains of green and blue carbonate copper ore were met with in the iron gossan, but no appearance of copper has occured in any other part of the workings of the north shaft. At the depth of 23 fms. the iron gossan assumed a decomposed appearance, and gradually died out; then a thorough change took place in the character of the lode, and of the country adjacent to the lode; the lode under the iron gossan consists chiefly of prian, with heads of the same running into the country. At the depth of 25 fms., in ground as just described, a branch of rich copper ore about 3 in. wide, was met with on Friday last, the 19th July, and I am now glad to inform you that at the depth of the present bottom of the shaft (viz., 26 fms.) the branch of copper has gradually increased in size; it is now 10 in. wide, composed of red oxide, black oxide, and grey copper ore. The lode on each side of the branch of ore is composed of prian, strongly stained with green and blue carbonate of copper ores. I send you with this letter stones representing the best of the ore. Parcel No 1: Red oxide and steel grey copper ores, which will yield about 70 per cent. of copper.—No. 2: Black oxide and soft grey ore, which will yield about 60 per cent. of copper. The fact that copper ores have been found immediately under the strong iron gossan I regard as a very important and valuable discovery. The present bottom of the north shaft is the only place where the iron gossan has been sunk through, and there copper of high percentage has been found, and strong indications that further improvements will follow."

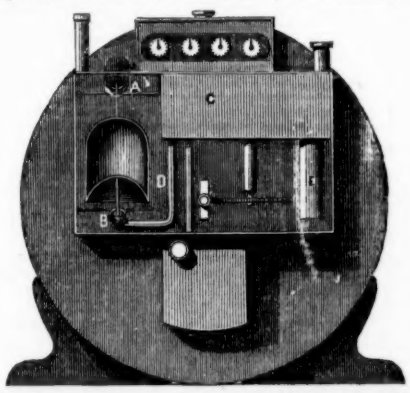
ENGLISH AND AUSTRALIAN COPPER.—The furnaces have been let out for a week for repairs, and at date there were about six at work again, besides refineries. The stock of coal at date was about 3100, besides 940 tons not unshipped; and of wood about 4800. The make of copper and the operations of the company were proceeding very satisfactorily.

PORT PHILLIP AND COLONIAL GOLD.—Quartz crushing has been going on at Clunes without interruption during the past month. The quantity crushed was 2803 tons, yielding 2078 ozs. 11 dwts. 5 grs. of gold, including the alloy, accumulated since March; this gives an average of 14 dwts. 19 grs. per ton, but deducting the alloy, only 11 dwts. 5 grs.—a considerable reduction on the previous return. We cannot always account for variations in the yield, the average of a series of months is, on the whole, satisfactory. The amount received on Clunes account was 3588*l.* 5*s.* 11d.; payments, 1631*l.* 17*s.* 7d.; balance cr., 1956*l.* 8*s.* 4d. The outlay per ton crushed was 11*s.* 1d.; ditto, deducting calcining and delivery account, 9*s.* 4d. For the quarter ending June the return is as follows:—9415 tons crushed, yielded 7333 ozs. 7 dwts. 19 grs. of gold, or an average of 15 dwts. 14 grs. per ton. The receipts for that period were 12,737*l.* 11*s.* 5d.; payments, 5672*l.* 7*s.* 6d.; balance profit, 7065*l.* 3*s.* 11d. This return compares favourably with that for the previous six months; the average amount crushed per week is 672 tons, against 567 for the former period, being an increase of 105 tons per week; the yield per ton is about the same, and the cost of reduction has diminished as the quantity of material operated on has increased. Should there be no accident or interruption to the works during the next three months, the result of the year's operations will be very favourable, and, no doubt, give renewed confidence to the shareholders in the undertaking.

SCOTTISH AUSTRALIAN.—At the Cape of Good Hope Mine, Dickson's shaft is now down nearly 28 fms. We cut a "dropper" (that is a branch from the main lode) about 3 in. wide, containing yellow ore and mundic, about 9 ft. back, underlying from S.W. to N.E. The Oakey Creek Copper Mine (a property of 564 acres), which it was stated in the last monthly report had been leased on very favourable terms by this company, has been inspected by Capt. J. P. Christoe, who thus reports—"The lode, which is very large and massive, runs east and west, with well-defined walls, and is composed at the surface of gossan, iron, and a little copper. The former proprietors raised about 100 tons of ore, varying in produce from 5 to 25 per cent. About 10 cwts. of the latter was blasted from the bottom of the winze, (say) 25 ft. from the surface, composed of grey ore, green carbonate, and red oxide of copper and iron. The ores runs in floors dipping to the east, and varying in thickness from 6 in. to 2 ft. and upwards; the width of the lode I estimate at 38 ft. The lode runs for a little more then half a mile through the property. For nearly two miles east and west the lode is distinctly seen; in some places the outcrop is very great. The character of the country is volcanic. The lode in appearance and character is by far the most promising I have ever seen, and I have not a doubt on my mind it will prove to be amazingly rich." The superintendent writes—"The specially favourable features in the Oakey Creek Mine, as they show themselves at present, are the ease with which ore can be got and fitted for the furnace, and the abundance of fuel at hand. These circumstances, we expect, will enable us to turn to profitable account ore of quite a low produce, and this has not been hitherto practicable in Australia." Smelting works are about to be erected, and mining operations commenced on this important property immediately. As regards the Wellesley coal field, a coal viewer has been engaged by the directors, and is on the eve of departure for the colony to prosecute operations there.

IMPROVEMENTS IN GAS METERS.

Mr. Henry Shaw, of Dublin, has invented an improved wet gas meter, in which the water may always be maintained at a correct level; the objects thereby gained being accurate registration and security against loss arising from the meter being tampered with. The subjoined drawing shows a front elevation of the ordinary wet meter, with the addition of a reservoir C, of a supply-pipe D, and of an inverted water-valve B. The inverted water-valve B is in connection with the ordinary float, and is raised or depressed with it. This water-valve, when raised to its seat, is



a perfect security against more water entering the meter from the reservoir C than may be required; and when the valve B is depressed it will admit water from the reservoir C by means of the supply-pipe D, until it is again in its seat. The means whereby the water line will remain undisturbed when the gas is being turned on, and which, if disturbed, would act prejudicially on the water-valve B, are simply by an adjustment of the opening through which the water passes from the front or float chamber to the wheel chamber, whilst the pressure from the gas so turned on is being equalised on both chambers. It is, therefore, apparent that a dead level may be maintained with positive certainty, except it be disturbed by being surreptitiously drawn off, or by evaporation, when the inverted water-valve will open and make good such deficiency from the reservoir C, which reservoir may be sufficiently capacious to hold a reserve supply to meet evaporation for years; and when emptied will give notice thereof by the closing of the gas-valve A, when the gas will be shut off from the meter altogether. The inverted water-valve is protected from decay or injury by its submersion in pure water, and by having its upper part within the concave form of the bottom of the float. Its susceptibility is thus preserved to the minutest variation of the water level, and which is at once apparent by the diminution of the lights, which go out when the water shall have fallen one-tenth of an inch, or about a difference of 2 per cent. E is the ordinary hydraulic pipe to prevent any escape of gas when the reservoir C is being refilled. Mr. Meacock, of Snow-hill, is the agent for the metropolis.

MANUFACTURE OF SULPHUROUS ACID.—To produce sulphurous acid Mr. C. A. Drevet, of Rouen, proposes to introduce through an opening into a cast-iron retort a quantity of sulphur, which he melts by heat from a furnace when it is inflamed. The retort is hermetically closed, and a current of air is caused to enter through a pipe, through a perforated plate, by means of bellows. The sulphurous acid thus produced passes through a receptacle divided into compartments in which flour of sulphur deposits, and is cooled in a leaden serpentine or worm, whence it is passed into the receptacle with compartments containing either water or a solution of a base or of a carbonate. The azote in a free state, and the carbonic acid gas (when he employs a carbonate), escapes into the atmosphere through an opening. A gas epurating apparatus is also employed when a bi-salt is formed. This apparatus consists of a box into which the end of a leaden pipe is immersed, through which passes the disengaged gas from the principal apparatus. These gasses are passed through an alkaline solution, and become freed from any sulphurous acid gas. He employs the bisulphite of soda obtained by this process for bleaching purposes.

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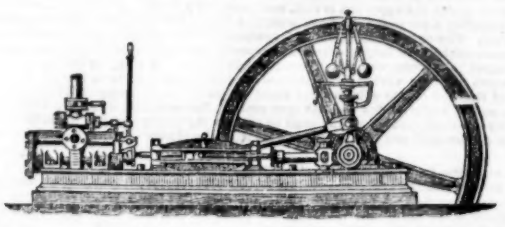

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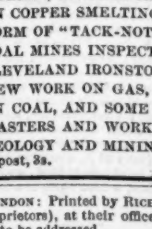

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